Pre-Plant Broadcast Urea in Direct Seeding, A Logistical Return to the Past?

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ABSTRACT

A study was conducted to compare the crop yield response between fall and spring surface broadcast applications of urea to the industry standard of side-banding urea during the spring planting operation. The results of a four-year study of barley direct seeded (no-till) at Ellerslie, AB, having treatments of fall and spring applications of surface applied urea, with and without urease and nitrification inhibitors, compared to side-banded urea at planting in the spring, showed that the broadcast applications performed well in comparison. There are numerous farm operations that are switching from side-banding to pre-plant broadcast urea applications to reduce the time of planting in the spring.

BACKGROUND

There are three main sources of nitrogen (N) fertilizer commercially available in the western Canada market. These are pressurized liquid anhydrous ammonia (82-0-0), granular urea 46-0-0), and liquid urea ammonium nitrate (28 or 30-0-0). Previous to the year 2005 there was also access to granular ammonium nitrate (34-0-0). But due to added security costs and risks 34-0-0 is not readily available. There are three main potential loss mechanisms of N, after N fertilizer is applied to soils. One is leaching of nitrate with water moving through the soil profile, another is denitrification of nitrate under saturated soil conditions primarily in the spring at time of snowmelt, and ammonia volatilization losses from surface applications of urea fertilizer, when there is sufficient moisture to dissolve the urea, but not move it into the soil.

When no-till or direct seeding was first introduced to western Canada cropping systems, the common way to apply N fertilizer was broadcast operations. Under conventional tillage the N fertilizer was normally a pre-plant broadcast application followed by an incorporating tillage operation before planting. Early research evaluating surface applications of N fertilizer to no-till fields showed that ammonium nitrate had a higher use efficiency compared to urea. An early study near Foremost, AB, showed no difference in the content of N-15 enriched urea or ammonium nitrate, in wheat grain under conventional tillage when the N fertilizer was broadcast and incorporated with tillage prior to planting. However, under no-till cropping the surface applied ammonium nitrate had higher fertilizer uptake into the wheat grain compared to urea (Table 1). It was thought that the lower grain content of fertilizer N was due to ammonia volatilization losses when surface applying urea without incorporation with a tillage operation (Jensen 1985).

Table 1. Pre-plant broadcast fertilizer N uptake into spring wheat grain, Foremost, AB, 1980

Tillage System	N Fertilizer Form	Rate kg N/ha	% of Applied Fertilizer in Grain	Statistical Significance, 0.05% *
No-till, no incorporation	Urea	40	31	b
		80	23	b
	Ammonium Nitrate	40	52	a
		80	47	a
Conventional Tillage, with incorporation	Urea	40	39	a
		80	35	a
	Ammonium Nitrate	40	44	a
		80	33	a

*Separate analysis within tillage system, L.S.D. No-till 10, Conventional Tillage 14.

Further related research showed that when banded urea was compared to broadcast urea under no-till cropping, in two out of three site-years banding resulted in higher yields of spring wheat (Table 2).

Table 2. Spring wheat yields kg grain/ha, comparing broadcast urea to banded urea under no-till cropping

Placement of Urea Fertilizer	Rate kg N/ha	Site Year		
		Carmangay, AB, 1981	Carmangay, AB, 1982	Glenwood, AB, 1982
Broadcast	60	1802, b*	1433, b	1786, a
Banded	60	2690, a	1992, a	2040, a

* Statistical differences within each individual site year.

This and much other early 1980s research encouraged the development of planting equipment that was capable of side-banding N fertilizer at the time of planting. This N fertilizer placement method is now the most commonly used way to apply N fertilizer.

However, as farm size has become larger the logistical demands to plant large acres of crops within the short time frame of early to mid-May ideally, has encouraged farmers to consider returning to broadcasting urea as a pre-plant application, rather than side-banding urea during the planting operation. This is because the time saved by not stopping as long to fill planting equipment tanks with seed, starter fertilizer (mostly P fertilizer), and additionally handling the urea fertilizer, allows more acres to be planted in a day. On a large corporate farm, approximately 40,000 acres, in southern Saskatchewan it is estimated that shifting urea application to a pre-plant broadcast application allows planting to be completed two weeks earlier compared to side-banding at planting (source: personal communication with farm management). It is additionally estimated that crop yields are 15 to 20% greater due to earlier planting, compared to fields that would have been planted later in May instead.

MATERIALS AND METHODS

A four-year study was conducted at the University of Alberta research farm south of Edmonton, by applying various forms of urea fertilizer applied as a late fall or early spring broadcast operation under direct seeding, compared to the industry standard of side-banding untreated urea at planting. Barley was direct seeded on wheat or canola stubble for the years 2010 through 2013. The treatments in the study included both regular (4mm) and large granule urea (13mm), that was treated with, or not treated with an urease inhibitor (Agrotain), or the urease inhibitor plus one of two nitrification inhibitors (Nitrapyrin or DCD). The fall broadcast applications were done usually near mid-October , the spring applications were dome in mid-April, with planting done last week of April or first week of May each year depending on when field travel was possible. All N fertilizer rates were suboptimal (40 kg N/ha) to try to see if there were differences between the forms of the various treated urea products, and the side-banded urea at planting.

RESULTS AND DISCUSSION

It was expected that the industry standard of side-banding urea at planting would be the highest yielding treatment each year of the study. However, both the fall and spring broadcast applications with or without addition of a urease inhibitor, or a urease inhibitor plus a nitrification inhibitor yielded similarly compared to side-banding at planting (Table 3). Also, there was no observed difference between the size of urea granules. There was a significant observed response to added N fertilizer in all years except 2011, as observed by the check or zero-N treatment yielding lower than all N fertilizer treatments for those three years.

Table 3. Yield of barley (kg /ha), by N fertilizer placement treatment, at the U of A Research Farm south of Edmonton, AB, in years 2010 through 2013

Form-Timing - Placement	**2010**	**2011**	**2012**	**2013**
Urea Side-banded	**4710 a**	**3896 a**	**4307 ab**	**5373 ab**
Urea Spring Broadcast	**5031 a**	**4173 a**	**5097 a**	**5282 ab**
Urea Fall Broadcast	**5366 a**	**4325 a**	**5139 a**	**5692 ab**
Super Urea Fall Broadcast	5458 a	3982 a	5144 ab	5566 ab

Agrotain treated Urea Fall	5752 a	3761 a	4833 ab	6047 a
Large Super Urea Fall	6094 a	4756 a	5129 ab	5703 ab
Large Super Urea Spring	6044 a	4522 a	4806 ab	5353 ab
Check no N	3093 b	3488 a	4192 b	4625 b

CONCLUSIONS AND RECOMMENDATIONS

It appears that for the four years of this study, broadcast applications of urea at lower rates of N application give barley yields as high as side-banding urea at planting. This was unexpected, but maybe shows that perhaps there is not as great or consistent of advantage of band placement at planting compared to pre-plant broadcast applications as previously thought. Admittedly, it is quite possible that for the four site-years of this study rainfall was timely after broadcast applications and volatile losses of ammonia from broadcast urea applications under direct seeding were minimal or not experienced.
It is advised that this research be continued with a range of N fertilizer rates, as well as more years and include more research sites.

REFERENCE

Jensen T L. 1985. Methods of application of nitrogen fertilizer for no-till cropping. MSc Thesis, Department of Soil Science, University of Alberta, Edmonton, AB.

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Why Did We Go from Broadcast N to Banded N at Planting?

- **Agronomics – higher yields**
- **Environmental – less loss into the environment**
- **Economics – better net profits for farmers**

Commonly Commercially Available N Fertilizers

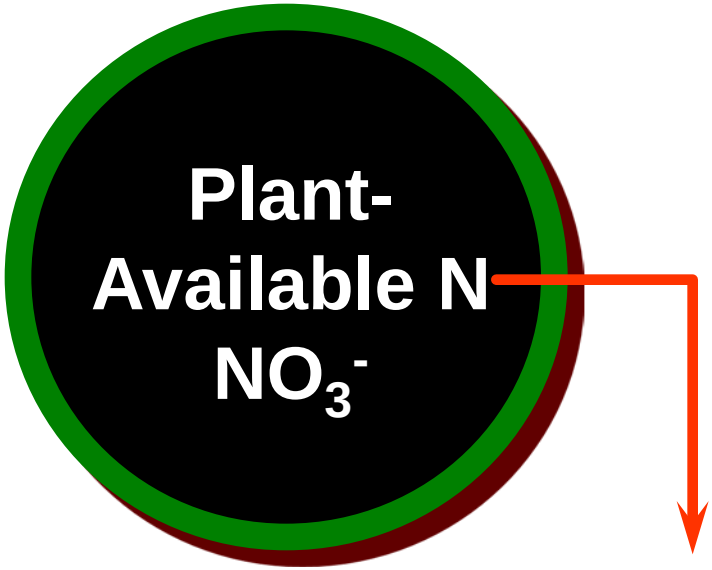
Name	Chemical Formula	Analysis % $N\text{-}P_2O_5\text{-}K_2O$
Anhydrous Ammonia	NH_3	**82-0-0**
Ammonium Nitrate**	NH_4NO^3	**34-0-0**
Urea*	$CO(NH_2)_2$	**46-0-0**
Urea Ammonium Nitrate (UAN) solution	$NH_4NO_3 + CO(NH_2)_2 + H_20$	**28-0-0/ 32-0-0**

*** Commonly available**

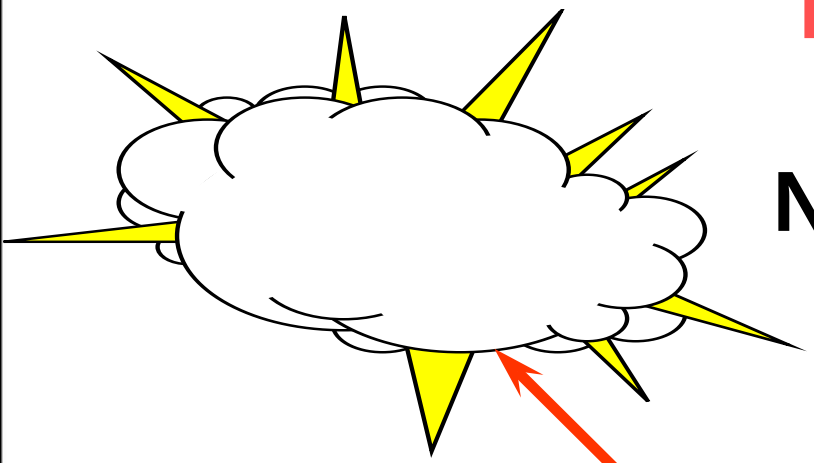
**** Very limited basically no availability**

Nitrogen Leaching

- Mobile NO_3^- removed from the root zone, perhaps NH_4^+ on a sandy soil by downward water movement
- Concern about contamination of groundwater



Denitrification



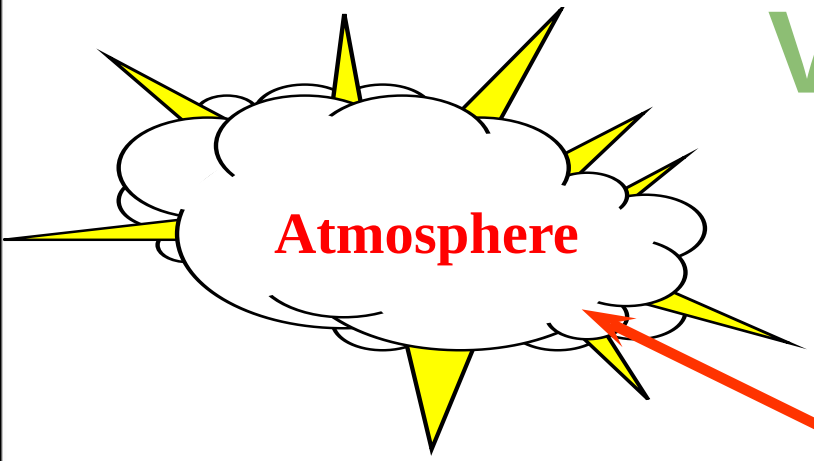
NO_3^- —(bacteria, without oxygen)→ N_2 or N_2O

N lost to the atmosphere as a gas

- **Wet soils (poor aeration)**
- **Increases with increasing temp**
- **Increases with crop residue amount**

Plant-Available NO_3^-

Volatilization



Loss of NH_3 gas to the atmosphere - NH_4^+ forms converted to NH_3

- **Surface applications of ammonium, high pH; or urea, urease enzyme on surface**
- **High temperatures**
- **Improper moisture conditions**
- **Improper application of ammonia**

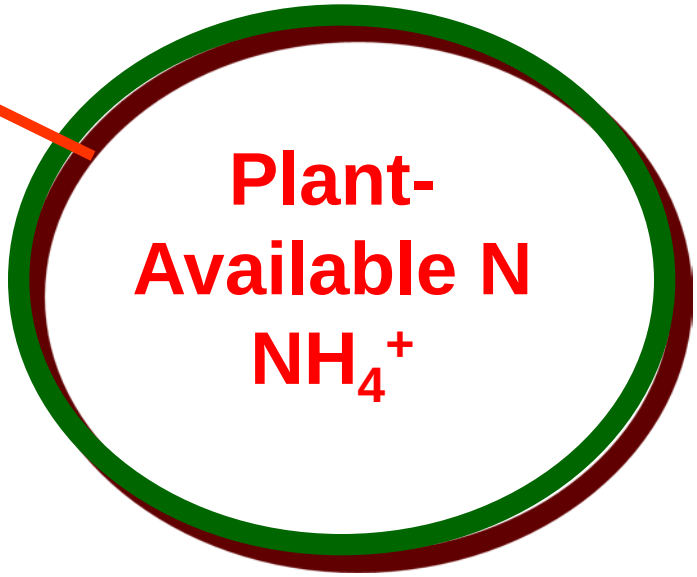


Table 4.1 Fertilizer use efficiencies, Foremost site 1980

EXPERIMENT	Treatment Form	Treatment N Rate (kg/ha)		FERTILIZER USE EFFICIENCY % (grain only)	
No-till	U	40	Urea	31	b
	U	80	Urea	23	b
	AN	40	Ammonium Nitrate	52	a
	AN	80	Ammonium Nitrate	47	a
Tilled	U	40	Urea	39	a
	U	80	Urea	35	a
	AN	40	Ammonium Nitrate	44	a
	AN	80	Ammonium Nitrate	33	a

U = Urea, AN = Ammonium Nitrate

L.S.D. at 95% confidence, No-till = 10, Tilled = 14

NH_3 Volatilization

Broadcast compared to banded

Table 4.5 Yields of treatments comparing three forms of nitrogen, placement, and rate of N for no-tillage

Form	Placement	N Rate (kg/ha)	EXPERIMENT Carmangay 1981	Carmangay 1982	Glenwood 1982
			kg grain/ha		
Check	none	0	1029	810	1134
AN	Broadcast	30	1744	989	1548
AN	Broadcast	60	2203	1716	1842
AN	Banded	30	1973	1278	1593
AN	Banded	60	2183	1900	1761
U	Broadcast	30	1640	1167	1660
U	Broadcast	60	1802 b	1433 b	1786 a
U	Banded	30	2253	1334	1694
U	Banded	60	2690 a	1992 a	2040 a
AA	Banded	30	2264	1141	1898
AA	Banded	60	2883	1572	1976
L.S.D. at 95% confidence =			524	526	474

AN = Ammonium Nitrate, AA = Anhydrous Ammonia, U = Urea

Timing and Placement of Ammonium Nitrate in No-till Wheat

Table D.2 Yield results of the fertilizer treatments and control treatments, Carmangay site N-15 experiment, 1982

TREATMENT	YIELD OF GRAIN kg/ha	
ISBr	1520	b
IFBr	1390	b c d
NTSBr	1660	b c
NTFBr	1530	b c
NTSBa	2180	a
NTFBa	2040	a b
I Control	1050	d e
NT Control	680	e

I = Incorporated, NT = No-tillage, S = Spring, F = Fall
Br = Broadcast. Ba = Banded
L.S.D. at 95% confidence = 510 kg/ha

Banding Benefit for No-Till Cropping

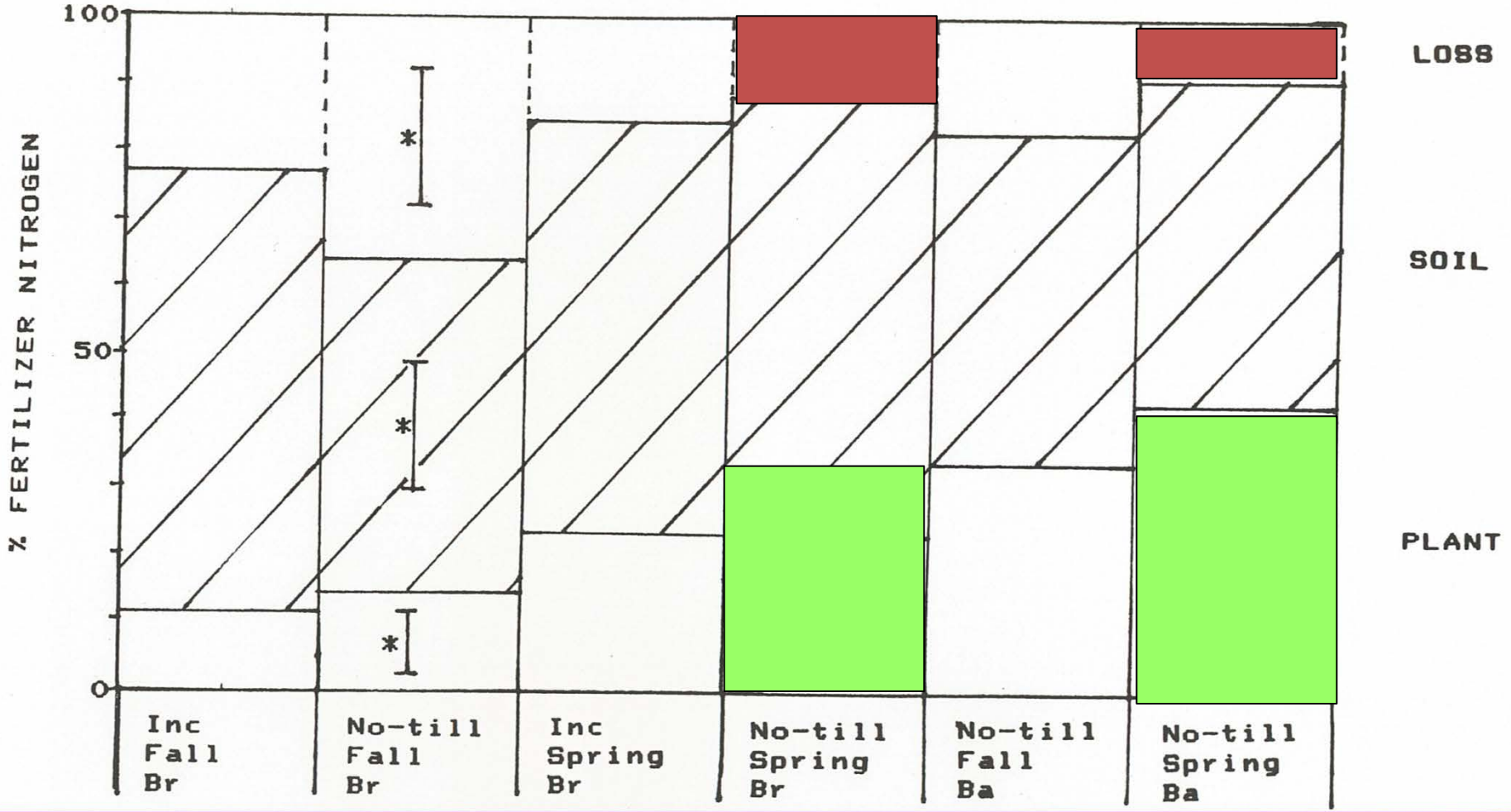


Figure 2 Fertilizer nitrogen recovery

(Inc = incorporated, Br = Broadcast, Ba = Band, * = L.S.D. at 95% confidence)

- Right Form @
- Right Time
- Right Rate
- Right Placement,(Banded?)

Should we question whether or not Banding urea is superior enough compared to Broadcast urea?

- **My exposure to Montana and North Dakota**
  - **% farms side-banding <5%, 95% pre-plant broadcast for spring seeded crops**
- **Large corporate farms in SK choosing to broadcast urea, usually pre-plant**
  - Less time to plant during a limited planting season
    - 40,000 acres, planting done 2 weeks sooner, 15% yield advantage, earlier harvest
    - Less labor
  - Using urease inhibitor, lower potential volatile NH3 losses by half
  - Cheaper to own a couple of floaters and single shoot airdrills, compared to side-band airdrills and extra trucks plus labor to haul fertilizer during the planting operation.
- **Recent research on urease and denitrification inhibitor treated urea**

Ellerslie, AB, Yield Barley, kg ha-1

LSD 1024 @ 0.05

Form-Timing - Placement	2010	2011	2012	2013
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Compare 90 kg N ha^{-1} Treatments

Form	Rate	Placement	Yield kg ha^{-1}	Statistical Significance
Agrotain	90	Broadcast Spring	6229	a
Ammonium Nitrate	90	Broadcast Spring	6145	a
Urea	**90**	**Broadcast Spring**	**6092**	**a b**
ESN	**90**	**Seed-Row Planting**	**5917**	**a b c**
Super Urea	90	Broadcast Spring	5768	b c
Super Urea	90	Band at Planting	5738	c
ESN	90	Band at Planting	5280	d
Urea	**90**	**Band at Planting**	**4659**	**e**
ESN	**90**	**Broadcast Spring**	**4520**	**e**
Agrotain	90	Band at Planting	4515	e
Ammonium Nitrate	**90**	**Band at Planting**	**3447**	**f**
Check	0	NA	2818	g
			336 LSD at 0.05	

Is banded urea as much better than broadcast urea as I thought?

- Maybe
- Maybe not
- Needs more research?

Questions